DOCUMENT RESUME

ED 428 734 IR 019 395

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TITLE	Actor Interdependence in Collaborative Telelearning.
PUB DATE	1998-06-00
NOTE	8p.; In: ED-MEDIA/ED-TELECOM 98 World Conference on Educational Multimedia and Hypermedia & World Conference on Educational Telecommunications. Proceedings (10th, Freiburg, Germany, June 20-25, 1998); see IR 019 307. Figures may not reproduce clearly.
PUB TYPE	Reports - Descriptive (141) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Business Administration Education; *Computer Assisted Instruction; Computer Managed Instruction; Computer Simulation; *Cooperative Learning; Coordination; *Distance Education; Educational Technology; Foreign Countries; Higher Education; *Instructional Design; Interaction; Learning Activities; Models; Strategic Planning; *Teamwork; World Wide Web
IDENTIFIERS	*Collaborative Learning; *Interdependence; Learning Environments; Scenarios

ABSTRACT

This paper presents a model of collaborative telelearning and describes how coordination theory has provided a framework for the analysis of actor (inter)dependencies in this scenario. The model is intended to inform the instructional design of learning scenarios, the technological design of the telelearning environment, and the design of intelligent agents to mediate or to support the mediation of collaborative telelearning. The first section introduces the challenges of telelearning, focusing on the fluid mediation of collaborative learning activity. Computer supported collaborative learning (CSCL) and coordination theory are discussed in the second section. The third section presents the model and its use in distance learning in a strategic management course at Ecole des Hautes Etudes Commerciales in Montreal (Canada); the part of the course that the learning scenarios document utilizes Netstrat, an Internet-based strategic management simulation. Reading the model is explained in the next section. The fifth section discusses the analysis of dependencies between actors in distance learning scenarios and describes the concept of collaborative shared interdependence through a shared activity. A table presents dependencies between activities. Four figures illustrate: the Netstrat simulation game; features of the strategic management course and Netstrat; and the third year learning scenario model. (Contains 11 references.) (DLS)

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Actor Interdependence in Collaborative Telelearning

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ED 428 734

Abstract: In our research we are developing an interdependence model for collaborative telelearning. We envisage that such a model will inform the instructional design of learning scenarios, the technological design of the telelearning environment and the design of intelligent agents to mediate, or to support the mediation of collaborative telelearning. In this paper we present a model of a collaborative telelearning scenario and describe how coordination theory has provided a framework for the analysis of actor (inter)dependencies in this scenario.

1. Introduction

Collaborative telelearning emphasises the collaborative interaction between students in a telelearning environment. The fluid mediation of collaborative learning activity is a major challenge for telelearning. Mechanisms to support synchronisation, exchange and sharing of information or documents need to be as transparent as possible to avoid hindering learning. An environment capable of supporting collaborative telelearning needs to be knowledgeable about organising and supporting the collaboration.

The design of collaborative telelearning requires the instructional design of collaborative learning scenarios and the specification of the technological design comprising the learning environment configuration as well as the tools and services available. Furthermore, the specification of software agents to mediate the time, space and collaborative learning activity distance between students, is a means to including some needed knowledge about organising and supporting collaboration.

In our research [Bourdeau et al, 1997; Bourdeau & Wasson, 1997; Wasson 1997] within the Canadian Telelearning Programme (http://www.telelearn.ca), we are developing an interdependence model for collaborative telelearning. We envisage that such a model will inform the instructional design of learning scenarios, the technological design of the telelearning environment and the design of intelligent agents to mediate, or to support the mediation of collaborative telelearning. In this paper, our approach to building this model is described and an analysis of actor (inter)dependencies in a collaborative telelearning scenario is presented.

2. CSCL and Coordination theory

Computer supported collaborative learning (CSCL) gives an insight into what collaborative telelearning can be. Salomon's work on CSCL [Salomon, 1992; 1993] provides the most complete approach to the study of CSCL in that it is built upon learning theories, relies on observations, raises strong design issues and gives methodological tools for educational research. Salomon's focus is on the mediation in CSCL, which is a key issue in collaborative telelearning. In his view, collaboration means interdependencies, sharing, responsibility,

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and involvement. Instructional design issues become, for example, to orchestrate these interdependencies and the shared activities, while maintaining personal responsibility and mutual involvement [Bourdeau 1996].

Genuine interdependence is characterised by [Salomon 1992] as: the necessity to share information, meanings, conceptions and conclusions; a division of labour where roles of team members complement one another in a joint endeavour and the end product requires this pooling of different roles; and, the need for joint thinking in explicit terms that can be examined, changed, and elaborated upon by peers. Salomon's emphasis on genuine interdependence between team members raises our first challenge: How can such interdependencies be specified and supported in a collaborative telelearning situation?

[Malone & Crowston, 1994] describe coordination theory as an emerging research area focused on the interdisciplinary study of how coordination can occur in diverse kinds of systems. Coordination theory provides a means for specifying (inter)dependencies between, and among, actors, tasks, and resources by identifying a *dependency type* (e.g., shared resource) and a *coordination process* (e.g., group decision-making) for managing the dependency. In their work, coordination is defined *as managing dependencies between activities* [Malone & Crowston, 1994], hence they have focused on dependence between activities. Drawing on ideas about activity coordination in complex systems from disciplines as varied as computer science, linguistics, psychology, economics, operations research and organisation theory, they present a first version of an analysis that characterises the basic processes involved in coordination. [Tab. 1] gives examples of dependencies between activities and possible coordination processes for managing them.

Using ideas from coordination theory, an (inter)dependence model for collaborative telelearning is being built [Wasson 1997].

Dependency	Examples of coordination processes for managing dependency
Shared resources	"First come/first serve", priority order, budgets, managerial decision, market-like bidding
Task assignments	(same as for "shared resources")
Producer/Consumer relationships	
Prerequisite constraints	Notification, sequencing, tracing
Transfer	Inventory management (e.g., "Just In Time", "Economic Order Quality")
Usability	Standardisation, ask users, participatory design
Design for manufacturability	Concurrent engineering
Simultaneity constraints	Scheduling, synchronisation
Task / Subtask	Goal selection, task decomposition

Table 1: Dependencies between Activities [from Malone & Crowston, 1994]

3. Modelling a Collaborative Learning Scenario

Adoption of Salomon's definition of genuine interdependence has lead us to focus on the ponderation of interdependencies between actors such as individual students, teams/groups of students, instructors, tutorial assistants, or experts. Empirical studies have been carried out in order to document collaborative learning scenarios for various versions of a strategic management course given at HEC, École des Hautes Études

Commerciales in Montréal [Wasson 1997]. The part of the courses that the learning scenarios document are exercises utilizing Netstrat [Fig.1] an Internet-based (http://cetai.hec.ca/netstrat/), strategic management simulation used to provide students with an opportunity to experience a realistic market. Participants form teams and compete for Market Shares. These documented learning scenarios have been modeled using a knowledge modelling tool, MOT, developed at the LICEF Research Centre at Télé-université. These MOT models form the basis of our analysis of inter-actor (inter)dependence.

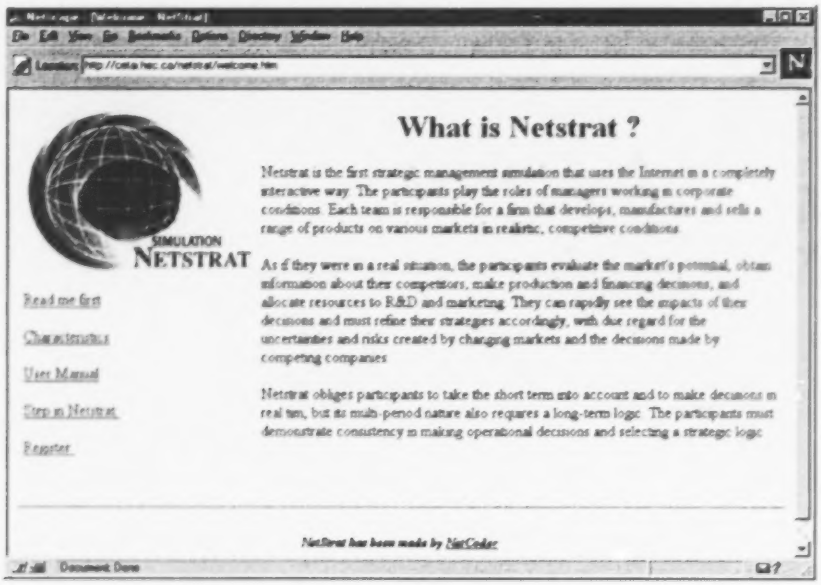
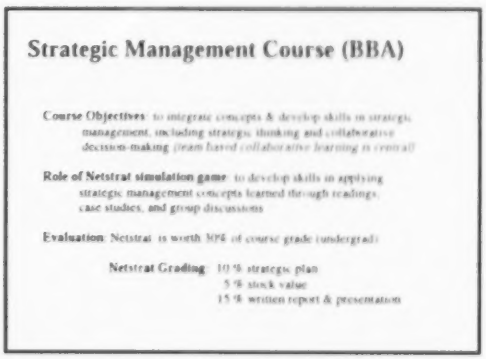


Figure 1: Netstrat Simulation Game on the Web

The Netstrat simulation game is used in 4 different variations of the strategic management course at HEC. There is a 3rd year undergraduate BAA course, an MBA graduate course, a 3-day Executive course for managers, and a 1-week tailored course for a particular industry. In each variation, the Netstrat simulation game is central, but its role and implementation varies. For example in the 3rd year BAA course [Fig. 2], a month long Netstrat competition [Fig. 3] is held half way through the course and serves to give the students a chance to practice the strategic management skills they have been learning about over the past three years. The MBA students, on the other hand, are welcomed to their program with an intensive week long Netstrat session that serves as an orientation exercise to highlight just how much they have to learn.


Strategic Management Course (BBA)
Course Objectives: to integrate concepts & develop skills in strategic management, including strategic thinking and collaborative decision-making (team based collaborative learning is central)
Role of Netstrat simulation game: to develop skills in applying strategic management concepts learned through readings, case studies, and group discussions
Evaluation: Netstrat is worth 30% of course grade (undergrad)
Netstrat Grading: 10 % strategic plan
5 % stock value
15 % written report & presentation

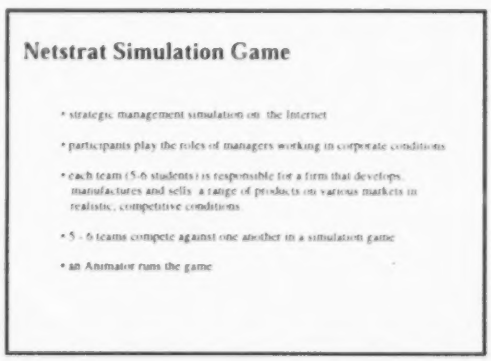

Netstrat Simulation Game
• strategic management simulation on the Internet
• participants play the roles of managers working in corporate conditions
• each team (5-6 students) is responsible for a firm that develops, manufactures and sells a range of products on various markets in realistic, competitive conditions
• 5 - 6 teams compete against one another in a simulation game
• an Animator runs the game

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Figure 2: Strategic Management Course at HEC **Figure 3:** Netstrat Simulation Game

The learning scenario for the 3rd year BAA documents student, instructor and a simulation animator's participation in the Netstrat competition. The major activities in which the actors are involved (although with varying roles) include: Briefing; Decision-making (7 rounds of team decision-making); Debriefing; Report writing; Team presentations; and Evaluation.

[Fig. 4] gives an overview of the model of the 3rd year BAA scenario emphasising the student view where collaborative team work plays a significant role (the complete model can be found in [Wasson 1997]). In this overview model, only the first three activities, briefing, decision making and debriefing are included. In the model actors are indicated as: an instructor (I); 200-250 students (S); an animator (A); teams of 5-6 students (Tx); and simulation groups (SG-x, i.e., a set of 5-6 teams). Goals are indicated by non-shadowed ovals, and activities by shadowed ovals. Concepts and resources are enclosed in rectangles and governing/regulating entities in diamonds. The shadowed elements indicate either a collaborative goal or activity, or a concept/resource that has been produced collaboratively. Links include: C - component; G-A - goal-activity; simultaneous, I/P - input/output; R - regulates; and P - precedence.

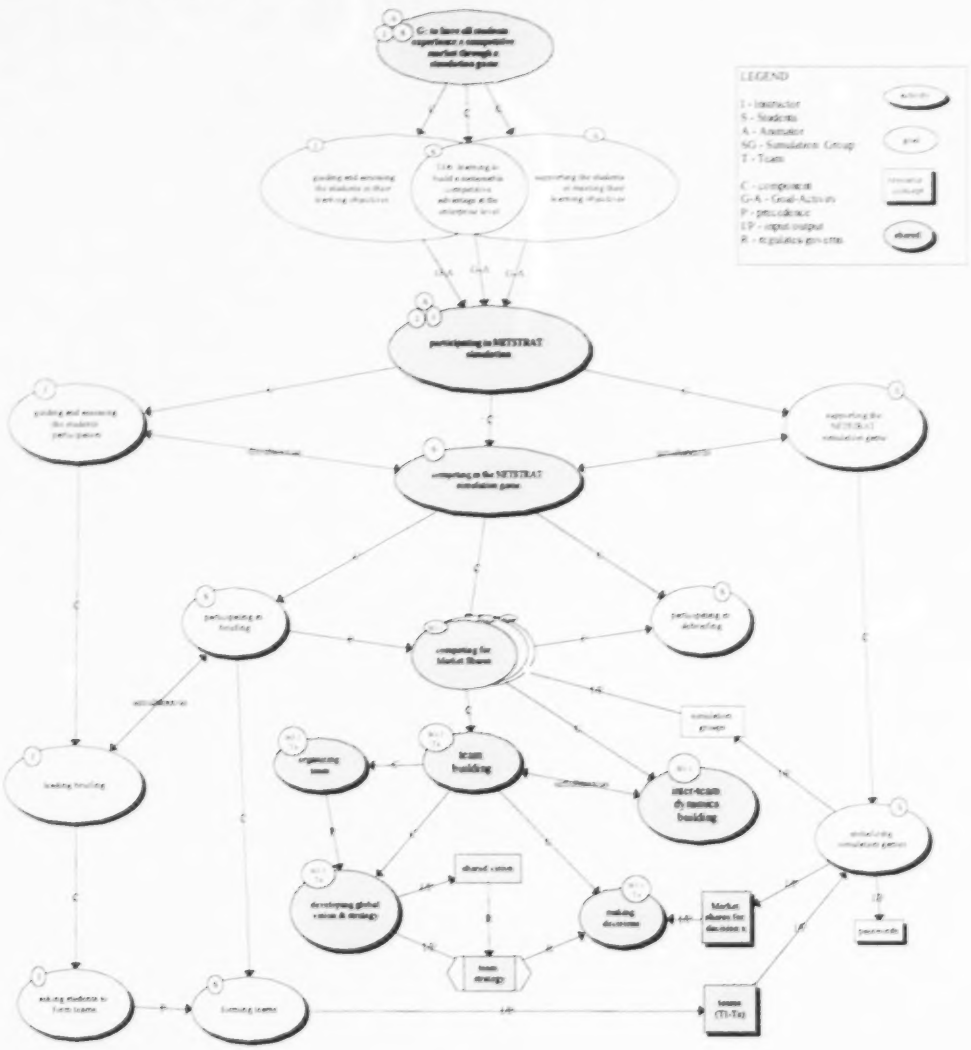

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Figure 4: An overview of the 3rd year BAA learning scenario model

4. Reading the Model

The top node of the model indicates that the instructor (I), the students (S) and the animator (A) share an overall goal "A,I,S: to have all students experience a competitive market through a simulation game". This goal is decomposed into three subgoals one for each of the actor roles. The instructor will meet the overall goal by "I: guiding and assessing the students in their learning objectives"; the students will meet the overall goal by meeting their learning objectives of which the overall objective is "S: learning to build a sustainable competitive advantage at the enterprise level" (three are 3 sub-learning objectives not shown here); and the animator will meet the overall goal by "A: supporting the students in meeting their learning objectives. Each of these subgoals is linked to a shared activity "A,I,S: participating in the Netstrat simulation" by a goal-activity link (G-A). Three simultaneous activities "I: guiding and assessing the students' participation", "S: competing in the Netstrat game", and "A: supporting the Netstrat simulation game" illustrate both the task/subtask and simultaneity constraint interdependencies identified by [Malone & Crowston, 1994] and listed in [Tab. 1].

Following the students activity three sub-activities nodes, "S: participating in the briefing", "SG-x: competing for Market Shares" and "S: participating in the debriefing" are met. There is a prerequisite constraint dependence [Tab. 1] between these activities indicated by the precedence (P) link. In the complete models [Wasson 1997] each of these nodes has a sub-model but for brevity only the highlights are shown. Notice here that in the second activity the students (S) have been divided into simulation groups (SG-x) and it is a SG-x that competes in one simulation game.

The simulation group activity "SG-x: competing for Market Shares" has two sub-activities "SG-x,Tx: team building" and "SG-x: inter-team dynamics building". More will be said about these two activities in the next section, but note that the simulation group has been split into teams (Tx) for the team building activity. Under "SG-x,Tx: team building" there are three sub-activities "organising team", "SG-x,Tx: developing global vision & strategy" and "SG-x,Tx: making decisions". These activities (of which there is a precedence order) are the heart of the collaborative team activity. Output (indicated by the I/P link) from the "SG-x,Tx: developing global vision & strategy" activity is a "shared vision" and a "team strategy". The shared vision is input into the team strategy which in turn governs (or regulates (R)) the "SG-x, Tx: making decisions" activity. This means that the team strategy has an influence over how team decisions are made. The final item to be highlighted is the "Market shares for decision x" concept. This concept represents the value of the Market Shares for which the teams within a simulation game are competing. The Market changes after each decision thus feeding new values into the next decision making round. The Market updates are released by the animator (not shown in [Fig. 4]) after a set criteria is met (e.g., all decisions have been entered by time x and no team will be out of the competition).

5. Discussion: Actor Interdependence

In analysing the dependencies between actors in the learning scenarios, the following observation has emerged. Actors in a collaborative telelearning situation have the obligation or necessity to:

- share Goals *to complete* Activities
- share Activities *to achieve* Goals
- share Resources to *complete* Activities
- share Activities to *produce* Resources

The first two are illustrated in [Fig. 4] by the interconnection of the overall shared goal's subgoals to the shared activity "A, I, S: participating in Netstrat simulation". This illustrates a *collaborative interdependence through a shared activity*. The shared activity is sub-divided into three activities which have a simultaneous constraint dependency as identified by Malone and Crowston [1994]. By carrying out these three activities simultaneously, each actor carries out their part of the collaborative activity which in turn satisfies the shared goal. The third

obligation arises in this learning scenario by the sharing of the actual Netstrat software to compete for the Market Shares. This *sharing of a resource to complete an activity* is not illustrated in [Fig. 4]. The last obligation is illustrated in [Fig. 4] by *the shared team activity* "SG-x,Tx: develop global vision & strategy" *production of the concepts/resources* "shared vision" and "team strategy".

Another aspect of this learning scenario that is worth noting is that there are both collaborative and competitive interdependencies and they are interlaced within each other. The *collaborative shared goal* "A.I.S: to have all students experience a competitive market though a simulation game" is achieved by a *collaborative shared activity* "A.I.S: participating in Netstrat simulation" which includes a *competitive shared goal* "SG-x: competing for Market Shares" which comprises *collaborative shared activities* "SG-xTx: team building" and "SG-x: inter-team dynamics building".

6. Conclusions

Beyond the issues of reliability of computer communications and services, it critical for collaborative telelearning that environments possess the knowledge as well as the ability to orchestrate and support collaboration. The analysis of actor interdependence in collaborative telelearning scenarios has been the first step in the process of defining this knowledge. In the Norwegian project OCTA, we are proceeding to identify coordination processes to manage the interdependencies between actors and to determine how to mediate these within a collaborative telelearning environment. Fjuk's analytic framework [Fjuk 1995] that has a foundation in activity theory [Leontiev 1975] and integrates elements from CSCW/CSCL, situated learning and problem-oriented project pedagogy, provides a basis for the design of our investigations and evaluations in OCTA. In an activity theory approach to human interaction the unit of analysis is extended to include a social dimension where individual interactions are analysed as part of a collective activity. Furthermore, activity theory is especially strong in emphasising the role a mediating tool (e.g. a computer system) plays in this web of human activities and stresses that it must be seen in the context of the entire learning environment within which it will be used [Wasson 1996].

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Acknowledgements

Funding was provided by the Canadian TeleLearning Network of Centres of Excellence with contributions from LICEF Research Centre at Télé-université, Université de Montréal (UdeM), Université du Québec à Chicoutimi, Ministère des Relations Internationales du Québec, École des Hautes Études Commerciales in Montréal (HEC), and University of Bergen, Norway. In particular we thank Jean-Michel Viola, Guy Stanley (HEC), Laura Winer (UdeM), and Ileana de la Teja (LICEF).